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(54) RESISTIVE SOFT STARTER FOR ELECTROMOTOR

(57) The invention of resistive soft start electromotor is a new method to resolve the problems and drawbacks of present soft starters, including primary shock of current inrush and both conserves energy and is cost-effective. The inventive method of this invention is the employment of resistive soft start electromotor (soft startup) instead

of present starters. Hereby, coil resistance change can reduce the primary shock hitting the electromotor. In this starter, no heat is produced. So there exists no energy dissipation by heat. There exists, no need to get devices such as soft starter or inverter and as a result purchase expenses for those devices are removed.

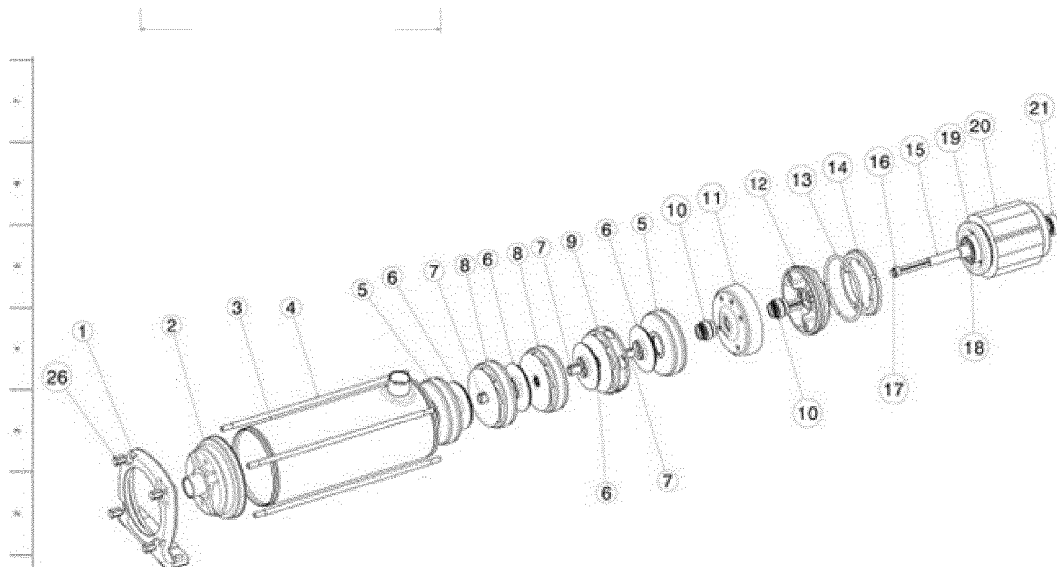


Fig. 9

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Description**TECHNICAL FIELD OF INVENTION:**

5 **[0001]** The present invention is related to electronics field, and it is a device to start the electromotors in a soft gradual way.

PRIOR ART:

10 **[0002]** For the first time, a person named Frank Nola invented soft starters because the primary shock (stress) with high startup amp in starting the electromotors was always a big problem and could cause the engine and its related equipments become kaput and its repair was costly. Currently, soft starters are invented in different kinds including frequency, transformer, voltage-reduction soft starters and inverters for energy conservation during consumption and protection of the invented machinery and equipment and all are in use, each of which has its own disadvantages.

15 Frequency soft starters are expensive in terms of production and lead to energy dissipation in thermal manner as frequency change leads to soft start and they produce heat and they consume energy themselves. Also, inverters should be kept under special condition and they also consume energy. Some of prior arts registered in the field are as follows: The invention with EP1901891B1 patent No. registered in European patent office with previous records, including a published patent in USA with US698233P and US788444P patent No. that presented by Black & Decker company

20 named soft start system for a powerful device, Some methods are provided for soft starting these type of device, including exist of the coil's starter in series with the ability to be added to stator's coil in series or out of the generator.

[0003] The same invention with CN205945566U patent No. presented in China is a type of controlling motor starter cabinet.

[0004] The invention with publication number of US6351113 B1 in 2000 under the title of "Integrated Soft Starter in USPTO which is in fact a kind of incorporated soft starter for electric motors in which the power switch of the starter is clamped between a pair of bus bars in an offset manner to accommodate a discrete switching relay mounted in an inverted manner between the line input and bus bar in communication with load output. The current, when in a motor run mode, is shunted away from the solid state power switching device and through the switching relay, a substantially linear current path is achieved to reduce power loss and heat buildup. The arrangement allows for a heat sink mounted to one of the bus bars with adequate spacing between the heat sink and the discrete relay for insertion of a cooling fan.

30 Current sensing is achieved with a Hall Effect sensor mounted to the bus bar in a small current sensing region that is created by having a pair slots in the bus bar to direct current. A pair of magnetic pins extended perpendicular from the bus bar to create the magnetic flux for the Hall Effect sensor to sense current flow through the current sensing region. The Hall Effect sensor circuit board also contains a thermostat which is mounted with adequate insulation yet in thermal communication with the bus bar.

[0005] The next similar invention under publication number of US9160257 B2 in 2013 is "Soft Starter system and method of operating same" registered in USPTO. The invention is a system and method for automatically defining and tuning operating parameters for a motor control device electrically connectible to an AC motor and a controller that is programmed to define a motor start-up function based on a rated current of the motor, the motor start-up function comprising an initial torque factor and an initial ramp time. The controller also triggers switching devices of the motor according to the motor start-up function to inject current into the motor during a first trial run, monitors operating conditions of the motor and motor control device during the first trial run, modifies the motor start-up function based on the monitored operating conditions, and triggers the plurality of switching devices according to the modified motor start-up function to inject current into the motor during the subsequent trial run.

45 **[0006]** In previous inventions and also in existing technologies either by the input power switching system in electro-motor using control cabinets or by putting some coils in series, attempted to soft starting of electromotors. In cases that coil divided into parts and only one part enters into circuit as a part of series coil, that part is more likely to be damaged.

CURRENT PROBLEMS AND THE PURPOSE OF PRESENT INVENTION:

50 **[0007]** Nowadays, electromotors are employed in different fields and energy conservation and due protection thereof is a subject worthy of attention. The technical problem lies with the initial startup of electromotors which require big current inrush, which accordingly results in sometimes uncontrollable shock and causes damage to the different parts or even the electromotor itself.

55 **[0008]** Currently, soft starters of different kinds, including frequency, voltage reduction, and transformer starters and inverters are used to prevent energy dissipation, electromotor protection and the removal of stress (shock) to electromotor in startup, each of which has got its own drawbacks. Inverters have got primary expenses and particular conditions of maintenance should be provided. Soft starters also and the existing inverters consume energy. For instance, frequency

soft starters which bring about soft start by frequency change produce considerable heat for the existence of electronic pieces and cause high energy consumption. On the other hand, the use of frequency soft starters is expensive and they themselves also consume energy.

[0009] The present invention is a new method for resolving the mentioned problems and drawbacks such as reducing the initial startup stress (shock) of electromotor, which in turn leads to energy conservation and is also cheaper. The purposes of the invention of the resistive soft start except for the points mentioned above, are as follows:

1- Soft startup and removal of initial stress (shock) of electromotor in initial start which renders different parts intact and eventually longevity of electromotor.

2- Energy conservation: For instance, if motor start ampere is nominal 4, for initial operation the required ampere is 12 whereas in the present invention it reduces to 5/5 for initial operation.

3- In the present invention, electromotor starts and turns off successively with being damaged because of the operation method of electromotor which started in resistive soft start mode.

4- This does not include a considerable cost and is cost-effective as inverter and soft starter purchase is not required.

DESCRIPTION OF THE INVENTION:

[0010] The inventive method of the invention is the employment of resistive soft start electromotor (soft operation) instead of the existing soft starters such that the initial coil resistance change can reduce the initial shock(stress) entering the electromotor. In this starter, no heat is produced which causes the energy waste by heat. It is noteworthy that inverters and existing soft starts are separate devices which are connected to machineries and cause soft start, for the preparation of which a great amount of expenses should be covered so they could be attached to related device and machinery whereas this invention has a very low expense and does not consume energy and creates the resistance by changing electromotor coil and brings about the soft start. In fact, there exists no need to buy soft starter or inverter. This method removes the expenses of these devices' purchase. We had better mention that this design is appropriate for almost 80% of electromotors. Resistive soft starter of electromotors (soft start operation) creates resistance by changing coil design itself instead of frequency change, and the electromotor starts operating with low speed. When it obtained 60 to 80 percent of its own RPM (revolutions per min), the system disconnects the resistance with the help of contactor and timer from the circuit and put the electromotor in a normal condition. Design calculations for all the electromotors follow the similar rule. The system of the rule starts by series electromotor and continues in parallel mode after two to three seconds under normal conditions of the engine. As to the AC motor, for changing the electromotors from simple to resistive soft start mode, main coils of copper wire's cross section are divided and no change is made in RPM. Thus, main resistance increases by two times. This system returns to the main circuit by the contactor. In electromotors of compressors and pumps and electromotors of other applications, an installation of part for preliminary control can cause soft start. It had better be mentioned that this plan has been tested in single-phase and double-phase centrifugal pumps

Part 1: Single-phase Soft Starter Description (Fig. 1)

[0011]

1) The Components of Circuit: Single-phase switch (Fig. 3) for connecting or disconnecting main electric current

2) Fuse F1 for circuit protection

3) Timer KT1, for enforcing basic time of soft start

4) Contactor KM 1, which plays the main role in primary start in series and later parallel mode.

5) Main coil of electromotor L1

6) Main coil of electromotor L2

B) Circuit Operation Mode:

[0012] By main electric fuse switch(Fig. 3), the current first passes through the main coil L1 and permanent contact

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of connection. (6th column, Figures number 5) and then the main coil (L2). Hence, as the coils are positioned in a series mode and the division of input voltage, the start will be in soft style. Also, the other path of the electric connection by permanent contact KM1 is through (the third column of the figures) is in the path of timer KT 1 which triggers the operation of the timer. After the adjusted time of the timer passes by (for low-power electromotors, this time is 5 seconds) Contact KT1 path (the fourth column of the figures) becomes closed and accordingly the coil of contactor KM1 starts operating which in turn leads to the unlocking of closed KM1 and closing of the open ones (In the third, fourth and seventh columns of the figures). As a result, main coils of L1 and L2 become parallel and all the voltage input power is for two main coils (This happens when electromotor has been started)

[0013] Moreover, after timer KT1 operates, the closed KM1 blade (in the third column of figures) opens and the timer is disconnected from the circuit. For complete disconnection of circuit, it suffices that the main incoming switch (Fig. 3) is turned off.

[0014] Furthermore, the similar system is applicable for three-phase electromotors.

Second Part:

[0015] The complete Description of electromotor preparation:

The specifications of Stator coil:

[0016] The inner diameter of applied core: 55 mm
The outer diameter of the applied core: 110 mm
Height: 70 mm

Main coil:

[0017] Wire diameter (wound in two-ply format): 0.56 mm

Times of Revolution: 40 42 43 43

Start Winding:

[0018] The diameter of wire (wound in single-ply format): 0.56 mm

Times of Revolution: 80 80

The Technology of Development:

[0019]

1-The specified stator with respect to engine power is mounted in aluminum crust.

2-The electromotor shaft is mounted in a central rotor hole by hydraulic press.

3- Ball bearings are mounted on shafts.

4- Mounting the engine cap at the end of electromotor shell

5- The application of 4 six-millimeter screws, they are screwed down for 1.5 centimeters on the engine shell

6- Mounting the prepared shaft inside the motor shell and shaft ball bearing in the lower door.

7- Mounting the upper door on the engine

8- The application of four six-millimeter screws of 1.5 centimeters long. Screws are driven into the engine shell for 1.5 centimeters.

9- The installation of terminal upon the engine shell

10-The installation of the capacitor in the specified position and wiring the wires in the due terminal

11- Engine test (Electrical and Earth power test)

12- Mounting the chilling impeller at the end of the engine

13- Mounting and installation of the protection for chilling impeller by 4 five-millimeter screws,

14- Final control of the engine

15- Closing the terminal gate of the engine

16-The installation of engine stands under the shell

[0020] This resistive soft start electromotor (soft startup), can be applied with respect to 80% electromotors and compressors and pumps which are employed for different usages. Resolving the rush-in current primary shock leads to the longevity of electromotors, which causes more energy conservation, is cost-effective and available.

[0021] As design calculations for all the electromotors follow the same law, the system of this law starts with series electromotors , and operates after two to three seconds under normal conditions of the engine.

BRIEF DESCRIPTION OF FIGURES:

[0022]

Figure number one: Single-phase Soft Starter Circuit

Figure number two: Single-phase normal coil electromotor

Figure number three: Soft start special coil for single-phase copper wire cross section

Figure number four: Switching primary coil after two seconds to normal condition (single phase)

Figure number five: Normal coil for triple-phase electromotor

Figure number six: Soft starter coil system and wiring position in triple-phase motor

Figure number seven: Wiring and switching mode of winding in triple-phase motor after startup

Figure number eight: Schematic of centrifugal electropump

Figure number nine: Explosive figure of electropump

THE CLEAR EXPRESSION OF THE ADVANTAGES OF THE

INVENTION:

[0023] The advantage of resistive soft starter in comparison to other soft starters:

- In a resistive soft start system of electromotor,(soft starter), the possibility of the system being defunct borders on zero for the application of coiled electromotor and it can consecutively turns on and off under difficult conditions.
- The drastic decrease of the damages to the electromotor and its pieces caused by mechanic blows in startup and accordingly the longevity of the electromotor and its constituent parts
- The low expenses of it which reduces to one-twentieth in low-power electromotors and one-hundredth in high-power electromotors
- In resistive soft start electromotor, there is no excessive part and electromotor control system does not change, and exist on all boards of electromotor control.
- Energy dissipated in soft starters and inverters is saved in the resistive soft starter.
- The reduction of electromotor power for preventing electrical shock leads to its longevity.

THE DESCRIPTION OF AT LEAST ONE EXECUTIVE METHOD OF EMPLOYING THE INVENTION:

[0024] The present invention is able to be used in up to 80% of the electromotors. However, we hereby describe its application in centrifugal pumps.

[0025] The Employment of Resistive Soft Starter in the construction of steel centrifugal pump:

The Specifications of Stator Coil:

The Applied Core:

[0026] Internal Diameter: 55 mm
External Diameter: 110 mm

Main Coil:

[0027]

The wire Diameter: (WOUND IN TWO-PLY FORMAT): 56 MM
56MM

Times of Revolution: 40 42 43 43

Start Coil:

[0028] Wire Diameter (wound in single-ply format): 0.56 mm

Times of Revolution: 80 80

The Required materials:

[0029] Two fixing stands of pump, one steel pipe of internal crust, four 8-millimeter stud bolts, 8 eight-millimeter nuts, three steel bushings , two mechanical seals, two cylindrical rings, one shaft, One flat bearing, triple multi-core wire, two steel head pumps, O-ring, one stator as explained above, one rotor as explained above, 6204 ball bearing, 6203 ball bearing, ten 6-millimeter bolt of 1.5 centimeter long , two spring rings, O-ring for cable , 100 cc edible paraffin wax, 4 impellers, countersunk screws , eight Allen screws, one steel pipe of external crust of pump, 5 diffusers, cable socket

1- Three-ply cable is tied by O-ring cable of number 25(Fig. 9) upon part 24(Fig. 9) (steel head pump) which is sealed by cylindrical O-ring inside gland.

2- Mounting PVC O-rings on parts 22(Fig. 9) (two), 23, 12, 3(Fig. 9) (two)

3- Mounting motor (specific stator or coil) inside steel pipe of number 22 (inner crust) (Fig. 9)

4- After machining, the steel shaft of number 15(Fig. 9) is mounted by hydraulic press inside central rotor hole of number 20(Fig. 9)

5- Mounting ball bearings of number 21 and 18 (Fig. 9)(ball bearings 6203 and 6204) on shaft of number 15(Fig. 9)

6-Mounting the aluminum ring of number 14(Fig. 9) and spring ring of number 13(Fig. 9) and aluminum mechanic seal position of number 12(Fig. 9) inside steel pipe of number 22(inner crust)(Fig. 9)

7-Mounting the prepared steel shaft inside the stator towards mechanical seal position of number 12(Fig. 9)

8- Mounting the second piece of number 14(aluminum ring) (Fig. 9), second spring ring of number 13(Fig. 9) from above inside the steel pipe of number 22(Fig. 9)

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9- The ball bearing position of number 23(Fig. 9) is mounted in upper section of steel pipe(22) (Fig. 9)

10- The installation of cable sockets (input electricity and earth) to capacitor and engine socket

11- The assembled engine undergoes electrical and earth power test.

12- Mounting mechanical seal of number 10(Fig. 9) in mechanical seal of steel shaft of 16 mm

13- Mounting steel part of number 11 (Fig. 9) (steel mechanical seal position) on part number 12(Fig. 9)(aluminum mechanical seal)

14- Mounting mechanical seal of number 10(Fig. 9) upon part number 11 (Fig. 9)

15- Sealing test by vacuum device

16- 100 cc of edible paraffin wax is injected to mechanical seal after sealing test

17- Mounting diffuser of number 5(Fig. 9)

18 Mounting impeller of number 6(Fig. 9) together with part number 9(Fig. 9) (water outlet diffuser)

19- Mounting inter-impeller bearing of number 7(Fig. 9) and impellers number 6(Fig. 9) and diffusers to number 8(Fig.9) respectively according to the provided schematic in figures

20- Mounting second part number 5 (simple diffuser) in upper section of the pump

21- Securing all the bearings and impellers and diffusers by steel screw M8 of number 17(Fig. 9) on shaft head.

22- Mounting stand of number one(Fig. 9) from motor cable.

23- Positioning the steel pipe of number 3(Fig. 9) (external shell of pump) in engine stand.

24- Fixing four stud bolts of M8 to number 4 in engine stand (Fig. 9)

25- Mounting steel part of number 2 (water inlet) on external shell(Fig. 9)

26- Mounting number 1 stand in upper section of pump upon part number 2(Fig. 9)

27- Securing stud bolts by nuts of M8 to number 26(Fig. 9)

28- Assembled pump undergoes tests regarding pumping capacity and other ones (control test)

[0030] As a result, shock of rush-in current reduced considerably by the application of resistive soft start. In Ac motor, cross section of copper wire is divided into two to change the simple electromotors to resistive soft start electromotors and as a result the times of revolutions do not change. Thus, the main resistance increases by two times more. This system returns to the main circuit by contactor. Around 80% of electromotors can start up with lower power in basic startup.

[0031] This single-phase circuit is tested by resistive soft start electromotor.

[0032] The first example is a normal coil for an electromotor with system of single-phase circuit capacitor (Fig. 2)

Coiled circuit for circuit startup (Fig. 3)

Changing simple coil to resistive soft start for copper wire cross section Coil circuit with capacitor (Parallel circuit)

After two seconds, it switches to (Fig. 4) circuit which is a parallel circuit: (Fig. 4)

The second example: Simple coil for three-phase circuit electromotor (Fig. 5)

The Switch of electromotor coil to resistive soft start for copper wire cross section (Fig. 6)

After two seconds, it switches to circuit (Fig. 7) which is a parallel circuit.

Claims

1. The invention of resistive soft start electromotor includes the following section:
Single-phase soft starter circuit which includes at least a single-phase switch, for connecting and disconnecting the main power source, and at least has a fuse for circuit protection, at least a timer for enforcing basic time for soft start, a contactor which plays the main role in series startup which later switches to parallel mode, at least a main coil of electromotor 1, and main coil of electromotor
2. The invention of claim one, in which the electromotor includes stator, rotor, copper wire, ball bearing, shaft and electromotor terminal, chilling impeller and the chilling impeller protection
3. The invention of claim one, in which stator that has been specified according to engine power is mounted in aluminum crust.
4. The invention of claim one, in which electromotor shaft is mounted after machining process inside the central rotor hole by hydraulic press.
5. The invention of claim one, in which ball bearings are mounted upon shaft.
6. The invention of claim one, in which the motor door is mounted at the end of motor shell.
7. The invention of claim one, in which four six-millimeter nuts 1.5 centimeters long are employed to fix the motor shell.
8. The invention of claim one, in which four six-millimeter nuts 1.5 centimeters long are employed to fix the motor door.
9. The invention of claim one, which is developed without adding any excessive part and only with changing electromotor coil.
10. The invention of claim one, in which the main coils of copper wire cross sections are divided into two and the number of revolutions does not change. Accordingly, main resistance doubles and this system return to the main circuit by the contactor. It functions such that electromotor starts operating at low speed and disconnects resistance from the circuit by the help of contactor and timer after reaching 60 to 80% of RPM and put the electromotor in normal condition.
11. The invention of claim one, in which electromotor can turn on and off consecutively under difficult conditions.
12. The invention of claim one, in which at the start of the electromotor's movement, a coil enters the circuit during the start process, then the second coil enters the circuit in parallel.
13. The invention of claim one, in which increasing of coil resistance by the halving wire diameter cause less ampere passes through the stator during the start process and applying less electrical load on net via electromotor.
14. The invention of claim one, in which the probability of stator winding damage during operation is minimized due to higher resistance to series models.

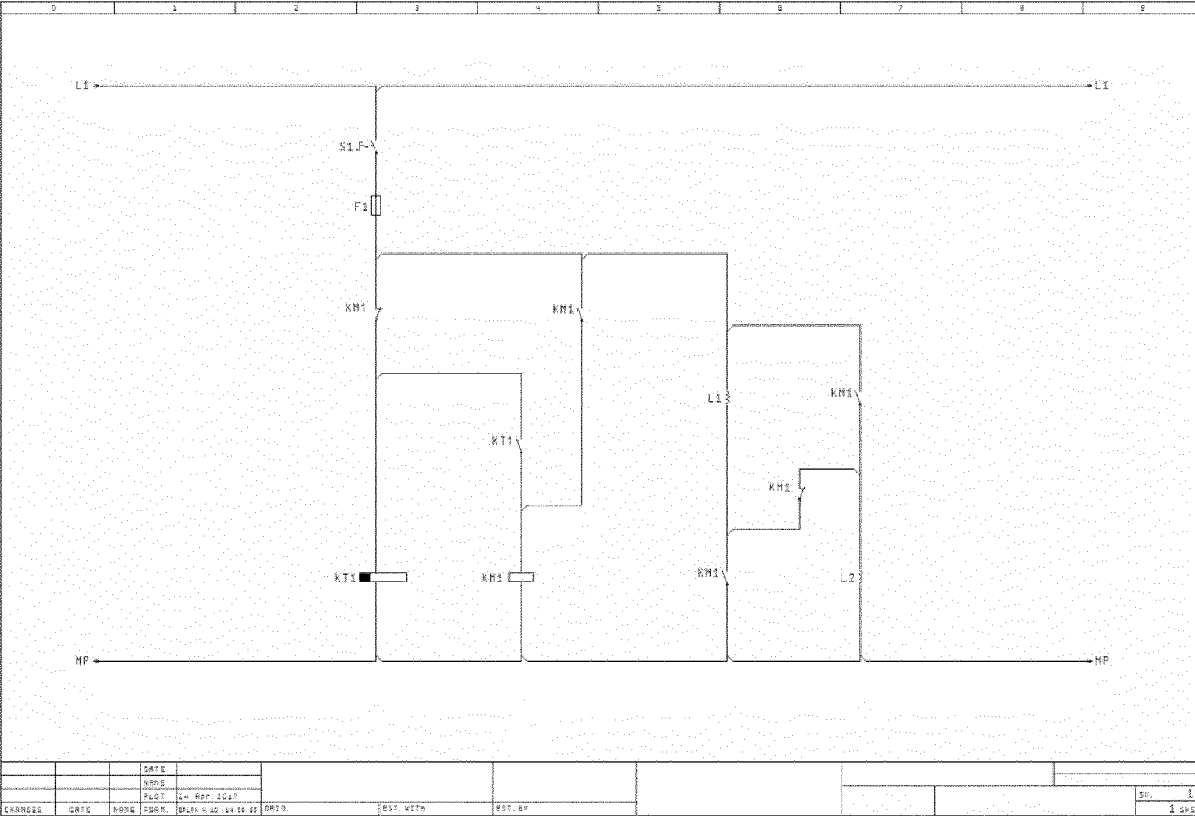


Fig. 1

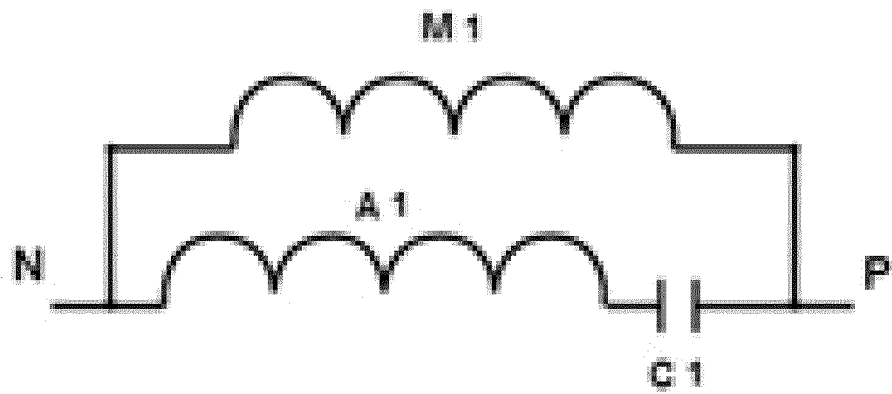


Fig. 2

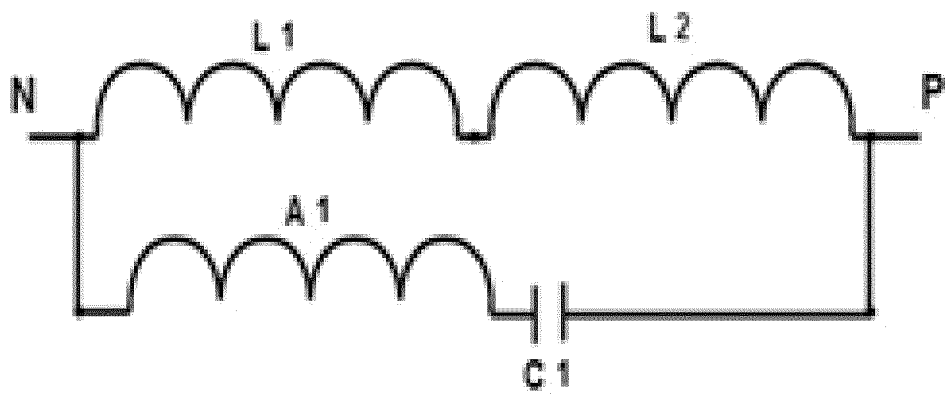


Fig. 3

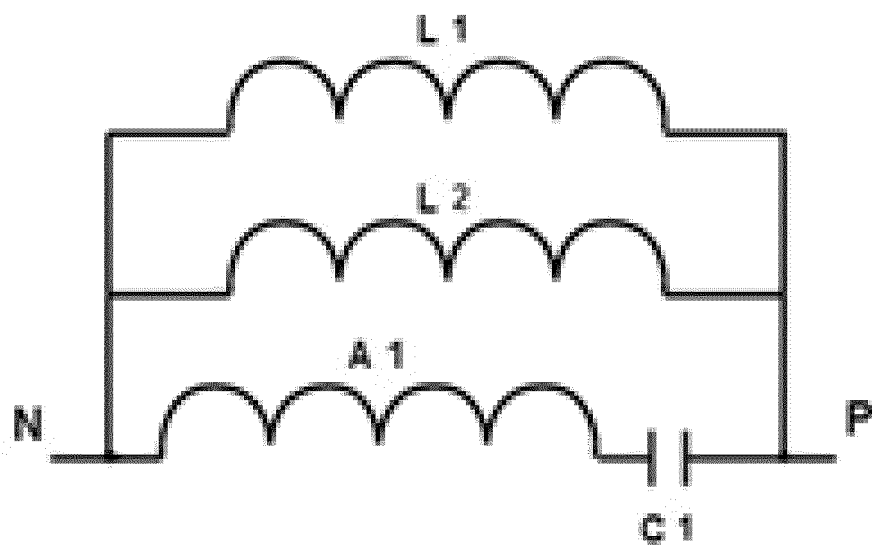


Fig. 4

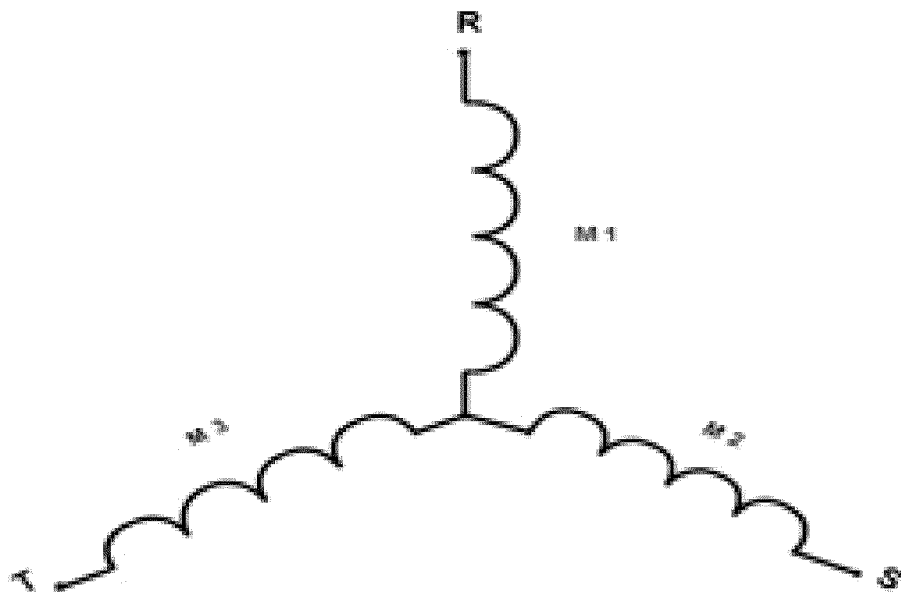


Fig. 5

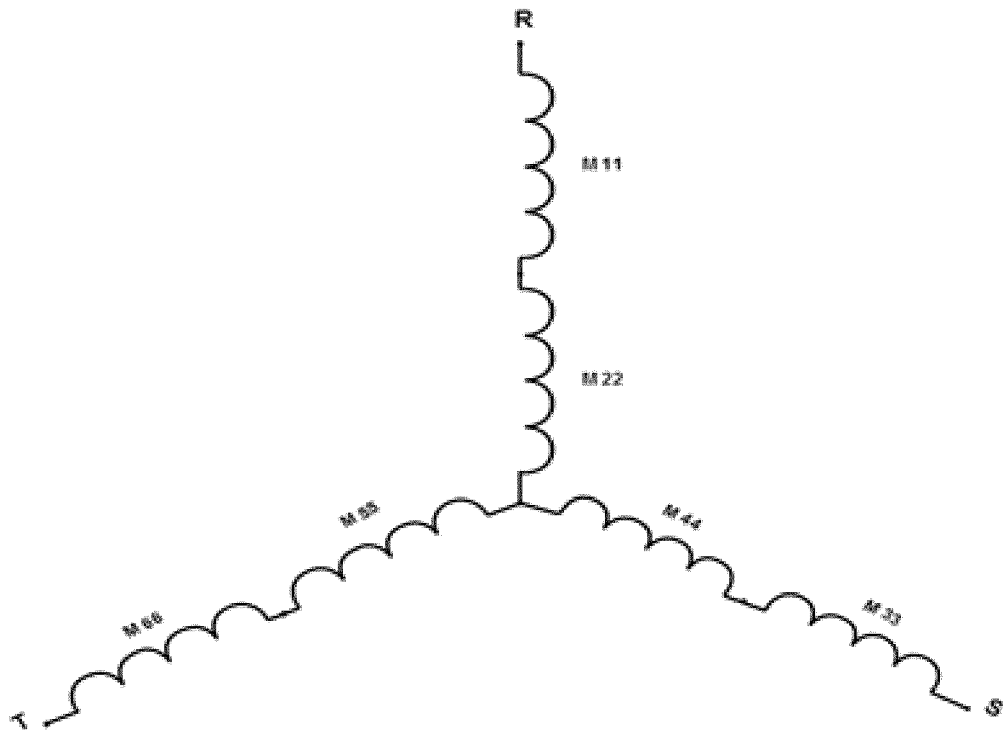


Fig. 6

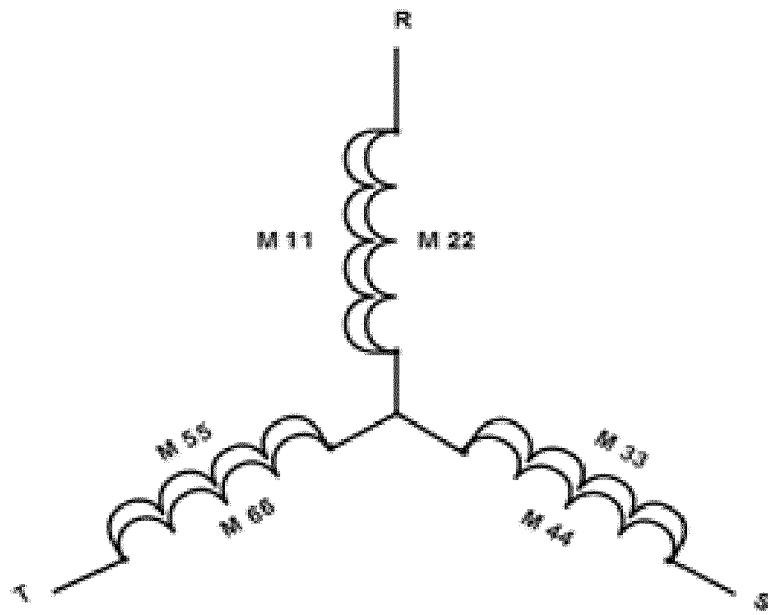


Fig. 7

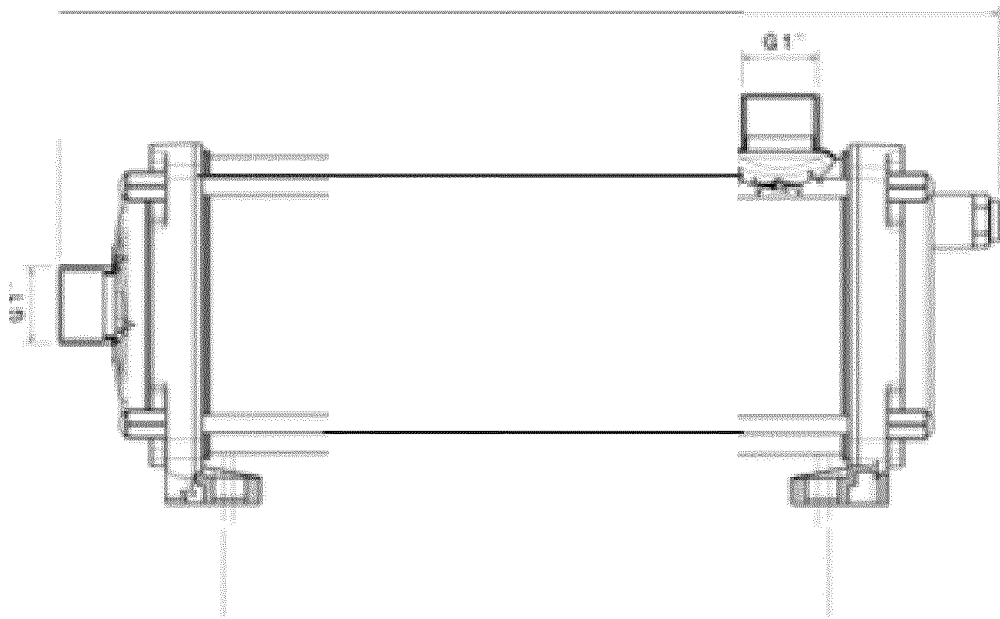


Fig. 8

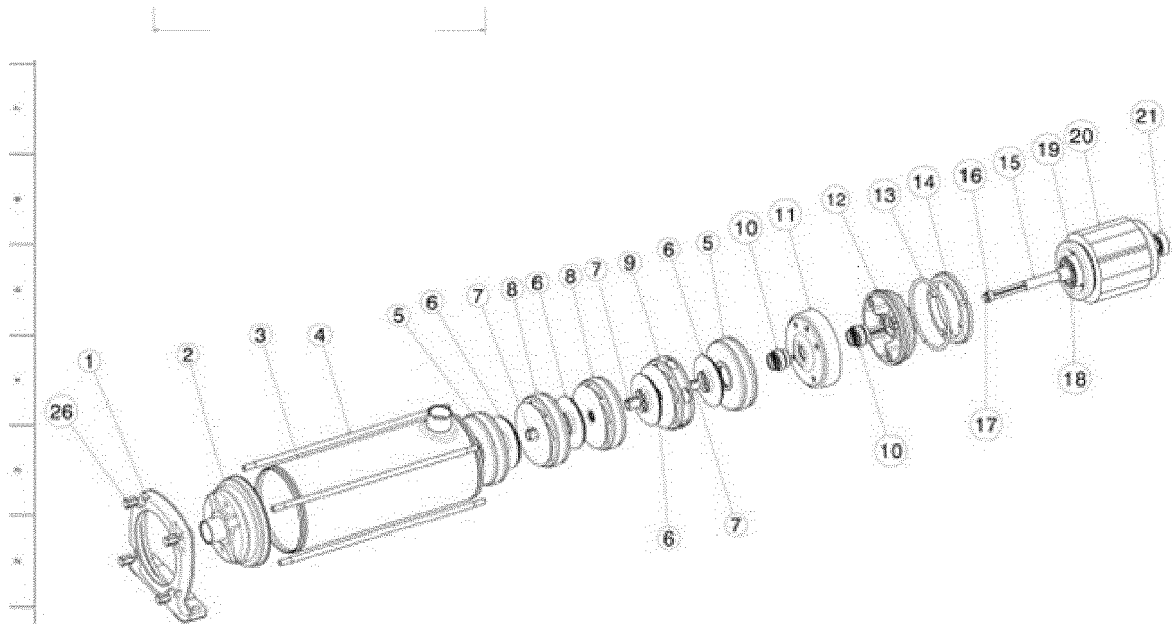


Fig. 9



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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 February 2020	Examiner Hascher, Thierry
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